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On the Forecasting Properties of the Alternative Leading Indicators for the German GDP:

Recent Evidence

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On the Forecasting Properties of the Alternative Leading Indicators for the German GDP: Recent Evidence*

Konstantin A. Kholodilin and Boriss Siliverstovs

November 9, 2005

Abstract

In this paper we perform a comparative study of the forecasting properties of the alternative leading indicators for Germany using the growth rates of German real GDP. We use the post-unification data which cover years from 1991 through 2004. We detect a structural break in the growth rates that occurs in the first half of 2001. Our results suggest that the forecasting ability of the leading indicators has been rather good in the pre-break period but it significantly deteriorated in the post-break period, i.e. in 2001–2004. None of the leading indicator models was able to predict and accommodate the structural break in the growth rates of the time series under scrutiny.

Keywords: Forecasting real GDP; diffusion index; leading indicators; PcGets.

JEL classification: E32; C10

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"Die Frühindikatoren haben uns 2002 massiv in die Irre geführt".

Joachim Scheide, Konjunkturchef am IfW,

"Handelsblatt" October 26, 2005

1 Motivation

In this paper we undertake a comparative study of forecasting performance of a wide range of alternative leading indicators available for Germany using the latest data. In doing so, our paper is related to rather extensive literature that assesses the forecasting properties of various leading indicators for Germany represented by Benner and Meier (2003), Breitung and Jagodzinski (2001), Dreger and Schumacher (2005), Fritsche and Stephan (2000), Hüfner and Schröder (2002a), and Hüfner and Schröder (2002b) for growth rates of German industrial production, and Dreger and Schumacher (2004), Hinze (2003), Langmantel (1999), Mittnik and Zadrozny (2004), and Schumacher (2005) for growth rates of German real GDP.

Despite this apparent abundance of the studies that employ the leading indicators for forecasting of either German GDP or industrial production, it is our impression that there is still a need for a comprehensive study that assesses their usefulness in forecasting of the key macroeconomic variables as the existing studies employ different methodologies, different estimation as well as forecast periods, and different sets of leading indicators in this type of exercise. Our paper intends to fill this gap in the literature by assessing the forecasting properties of a wide variety of alternative leading indicators available for Germany in a unified framework. As the reference series, or the time series to be forecast, we use the growth rates of the real German GDP.

Besides that our paper contributes to the literature in the following ways. First, we test for a structural break in the quarterly, semi-annual, and annual growth rates of the real German GDP and we find a convincing statistical evidence in favor of a structural break that takes place in the first half of 2001. This break happens to coincide with an unprecedentedly long recession detected by the OECD, which started in June 2000 and is not over at the moment of writing this article. However, it is hard to believe in such a long-lasting recession. Most probably we are facing a lengthy stagnation period, which is characterized

by the extremely low growth rates. This is an important finding as, to the best of our knowledge, none of the earlier studies cited above that forecast GDP over the specified period have neither checked for nor acknowledged the existence of such a structural break. Nevertheless, many German forecasting practitioners have been repeatedly signalled the sharp deterioration of the ability of the leading indicators to predict the German GDP since 2002. In addition, it is of a particular interest to investigate whether the leading indicators that are routinely used to monitor and forecast the state of the German economy are able to predict the enduring slump in the economic activity in the recent years.

Second, our research intends to contribute to the discussion of the usefulness of the diffusion indices in forecasting of economic activity. The diffusion indices have become a popular tool in forecasting following their introduction in the seminal article of Stock and Watson (2002). Up to date the diffusion indices have been successfully applied in Schneider and Spitzer (2004) for Austria, in Brisson et al. (2001) — for Canada, in Shintani (2003) — for Japan, in den Reijer (2005) — for the Netherlands, and in Camacho and Sancho (2003) — for Spain. Dreger and Schumacher (2004) and Schumacher (2005) are the only known studies to us that apply this methodology for Germany. To this end, our study complements that of Dreger and Schumacher (2004), who investigated the forecasting performance of the diffusion index model of Stock and Watson (2002) against the benchmark autoregressive model and the Ifo business climate indicator, and that of Schumacher (2005), who compared the forecasting performance of alternative methodologies for construction of diffusion indices based on Stock and Watson (2002), Kapetanions and Marcellino (2004), and Forni et al. (2002, 2004). Hence, out of two studies that employed the diffusion index methodology to the German GDP only the former compares its forecasting performance with that of only one alternative leading indicator. Given the multitude of alternative leading indicators that are available for Germany, this is clearly unsatisfactory as the (dis)advantage of using diffusion index models over other leading indicators is not sufficiently illustrated.

Third, following Stock and Watson (1999, 2002), Forni et al. (2002) as well as Dreger and Schumacher (2004), among others, we perform our forecasting exercise using a dynamic or multi-step estimation approach. Models that generate forecasts are selected using the Bayesian Information Criterion as well as using the automatic econometric model selection program PcGets, see Hendry and Krolzig (2001).

Again, our paper distinguishes itself from the rest of the literature cited above by applying the PcGets model selection program in forecasting of the state of German economic activity. Moreover, given rather few studies that use the PcGets model selection program in out-of-sample forecasting (e.g. Banerjee and Marcellino (2002), Hendry and Hubrich (2004), Hubrich (2005), and Banerjee et al. (2003)) our paper intends to contribute to the discussion of whether the PcGets, a sophisticated program that selects arguably the best model in-sample, has an edge over the much simpler model selection strategy based on the information criteria.

Our main results can be summarized as following. First, we find rather strong statistical evidence for existence of the structural break in the growth rates of real German GDP. The structural break occurs in the first half of year 2001 and entails drastic reduction in the unconditional mean and variance of the time series under scrutiny. Second, we utilize two measures of forecast accuracy: the Root Mean Squared Error and the Theil's U. On the basis of these two measures we find that the forecasting ability of the alternative indicator models differs markedly in the pre- and the post-break periods. In the pre-break period the diffusion indices display superior forecast accuracy over the rest of the models. However, in the post-break period all the leading indicator models fail to accommodate the structural break and as a result forecasts generated from these models largely overstate the growth rates at all forecast horizons. Third, the performance of the PcGets model selection strategy offers no noticeable improvements over the model selection strategy based on the Bayesian information criterion in terms of the forecast accuracy for our data at hand.

The paper has the following structure. Section 2 provides a literature review and discusses relation of our paper to the existing literature in more detail. In Section 3 we present the forecasting equation that we use in our exercise, motivate estimation and forecast periods, and stipulate the model selection methods. Section 4 discusses the obtained results. Finally, the last section concludes.

2 Literature and leading indicators review

In this section we briefly overview the previous studies that employed various leading indicators to forecast the state of the German economy. Given the large importance of German economy within the Euro Area, it is not surprising that its current stance and perspectives for its future development attract a lot of attention both at the national and international levels. As a result, there is a comparatively large number of alternative indicators developed by various institutions in order to meet these concerns.

Table 2 lists the alternative leading indicators that are used in this paper and in other articles, which we cite here and which examine the properties of these indicators in forecasting the German GDP and industrial production. In column 1 the organizations that provide these indicators are listed; column 2 contains the full official names of the indicators; column 3 describes the geographical area, for which the indicators are computed; column 4 gives a short mnemonic code for each indicator; and finally column 5 shows the time period, for which the indicators are available. Notice that the leading indicators for European Union (EU) and Euro Area (EA) are used, given the importance of these two country groups for the German economy, which may imply that the EU and EA indicators can be useful for the forecasting of the state of affairs in Germany. All these leading indicators are available at monthly frequency.

In addition to the already available leading indicators and following Stock and Watson (2002) we estimated the diffusion index using the principal components analysis. For the estimation of the diffusion index the total of 145 component series were used, which were taken from the online database of the Deutsche Bundesbank and are listed in Table 1. Some of the series have outliers, which were treated as missing values. Therefore the set of all the component series, including those with outliers, is called the non-balanced, or *total panel*. Whereas the dataset containing only the series without outliers is called the *balanced panel*. In addition, all the original time series have a noticeable seasonality. Therefore we filtered them using the SEATS-Tramo algorithm of Demetra package to obtain either seasonally adjusted series or the "trend and cycle" series (original series without seasonal and irregular components). According to the test for a number of factors of Bai and Ng (2002), only the first principal component has been found to be informative and therefore has been retained. As result, we have estimated four diffusion

indices: FB1SA, FB1TC, FT1SA145, and FT1TC145. Here FB1 and FT1 mean the first common factor of balanced and total panels, SA stands for "seasonally adjusted" and TC stands for "the sum of trend and cycle", while 145 denotes the number of time series in the non-balanced panel.

Table 3 presents the studies that have addressed this question for Germany. As seen, the reference time series that these studies have attempted to forecast is either year-on-year growth rates of the index of real industrial production (IIP, henceforth) or growth rates of real German GDP. In this study we follow the stream of the literature that evaluated the comparative forecasting performance of the leading indicators for the latter variable, as it reflects the state of the overall economy. Needless to say, that the industrial production represents less than 50% of the contemporary German economy. Moreover, the service sector plays an ever increasing role in the economy and it has the dynamics, which are qualitatively different from that of the industrial production. All in all, the GDP offers a more comprehensive picture of the general state of affairs than the IIP does. Nevertheless, we acknowledge that accurate forecasting of industrial production, or, equally, of separate components of GDP, is of a great practical importance. We, however, would like not to blur the focus of our investigation by addressing too many things at the same time and therefore we leave this exercise for our future research.

Returning to Table 3, we would like to note that none of the earlier studies listed there have employed the whole range of the alternative leading indicators. As seen most of the studies considered the relative forecasting performance of at most six different indicators like Breitung and Jagodzinski (2001), Dreger and Schumacher (2005), and Hinze (2003) or less. Often the choice of indicators overlaps, with Ifo, Early Bird, ZEW, and HB being the most popular ones. The rest of indicators appear once or twice and there are some indicators that never have been considered like the European Commission's Confidence and Economic Sentiment indicators, EuroCOIN, and OECD's CLI of Euro Area cycle. Moreover, the estimation and forecast samples also differ across the studies, see Figure 2. In addition to these two facts different studies employ different approaches to produce forecasts. For example, Benner and Meier (2003), Hinze (2003), Benner and Meier (2003), and Fritsche and Stephan (2000) use the bi-variate VARs for this purpose, whereas Dreger and Schumacher (2004) and Schumacher (2005) employ the dynamic or multi-step forecasting approach advocated in Stock and Watson (1999, 2002) and Forni et al. (2002), among

others. All these aspects, i.e. different sets of leading indicators, various estimation as well as forecast time periods, and finally different methodologies to produce forecasts, make comparison of the forecasting performance of various leading indicators of the state of German economy extremely complicated if ever possible. This is clearly unsatisfactory as these alternative indicators are routinely monitored and they contribute considerably to the policy making debate not only at the national but also at the international level. From this point of view, our paper could be considered as a first step in this direction, that offers an initial impulse to the all encompassing task of joint evaluation of the forecasting performance of the alternative leading indicators for Germany in the unified framework, i.e. we use the largest indicator set as compared to the previous research, we employ the same estimation as well as the forecast periods, and we use the same methodology to generate forecasts.

For the moment there exist several indicators that can be used to forecast German real GDP growth. For a detailed analysis of them see Breitung and Jagodzinski (2001) and Dreger and Schumacher (2004). Among the most important indicators, we can cite the interest-rate spread, or yield curve[1], Ifo and ZEW indicators as well as the diffusion indices constructed using the methodology suggested by Stock and Watson (2002).

3 Model setup

In this section we describe the setup of our forecasting exercise, i.e. the model that is used in order to generate forecasts, choice of leading indicators, as well as estimation and forecast samples. As mentioned above, in generating forecasts we follow the dynamic approach advocated in Stock and Watson (1999, 2002) and Forni et al. (2002), among others.

3.1 Model

Let y_t^h be the $h-$th difference of log of real GDP. Then for the quarterly data that we have, y_t^1, y_t^2, and y_t^4, denotes the quarterly, the semi-annual, and the annual growth rates of real GDP. Note that both y_t^1

[1] Duarte et al. (2005) show high predictive ability of the yield curve.

and y_t^2 are calculated on the year-on-year basis. The forecast equation is

$$y_{t+h}^h = \alpha + \sum_{i=0}^{p} \beta_i y_{t-i}^1 + \sum_{j=0}^{q} \gamma_j' z_{t-j} + \varepsilon_{t+h}^h, \tag{1}$$

where $h-$steps ahead growth rates of the reference time series are linearly projected on it own quarterly growth rates, y_{t-j}^1, as well as on the leading indicator values available at time t, z_{t-j}, for $i, j = 0, 1, 2, ..., q$. Here, unlike in the other studies, we use the indicators, z_t, both in levels and in first differences. Although we did not conduct the integration tests for the indicators, the visual inspection of them suggests that they may be near-integrated processes. Thus, the first differencing allows attenuating their inherent persistence. In our exercise we have restricted the maximum lag length to four, $p, q = 4$.

We compare the forecast accuracy of equation (1) with the benchmark "NAIVE" model, which is the restricted version of equation (1) with $\beta_i = 0$ and $\gamma_j = 0$ for all $i, j = 0, 1, 2, ..., q$. Thus the "NAIVE" model is nothing else as the unconditional mean of the growth rates calculated using the information available at time t. In addition, we have estimated the univariate autoregressive models for each y_{t+h}^h with fixed lag augmentation length, i.e. $p = 4$ and $\gamma_j = 0$ for all $i, j = 0, 1, 2, ..., q$, and with the autoregressive structure selected by the Bayesian information criterion. We denote these models as "FIX" and "BIC", respectively.

3.2 Sample

In the choice of estimation sample we have been confronted with several alternatives. One possible way is to take the longest time span that is available for a given indicator. However, this would imply that we combine the pre-unification and the post-unification time periods. As seen from Table 2, out of the four studies that referred to the GDP only one, i.e. Hinze (2003), employs the post-unification data. Nevertheless, most of the studies that referred to the IIP employ the post-unification data. In our paper, we also employ the post-unification data, since more than a half of the alternative indicators, including our own diffusion indices, are available from 1991 on — see Table 2.

Given these considerations, our sample covers the period 1991:II–2004:IV and hence comprises 55

observations only. As result, our prediction subsample is quite small: 1998:I-2004:IV, i.e. it consists of 28 out-of-sample forecasts for each forecast horizon. The forecasting was conducted using the *recursive* and *rolling* estimation windows. The former sampling method uses all the information available in the past, whereas the latter method puts more emphasis on the most recent observations and, thus, is more sensitive to the changes in the parameters.

3.3 Model selection

As discussed above, we use equation (1) to produce forecasts of the real German GDP. Allowing for maximum of four lags in both y_t^1 and z_t variables implies that up to nine parameters (including an intercept) are to be estimated. Given the sample size that is available to us, we run the risk of overfitting the regression. In order to avoid that we used two different model reduction approaches. The first one is based on use of Bayesian information criterion (BIC, henceforth). We compute its value for every combination of lags of both y_t^1 and z_t, including models where only an intercept and/or either of these two variables is present, and select a model that minimizes the value of BIC. Below we refer to this approach as "BIC".

As the alternative to the BIC approach we have employed the automatic econometric model selection program PcGets, see Hendry and Krolzig (2001). We estimated the model using the liberal, conservative, and expert strategies. Below we refer to this model selection approach as "PcGets".

4 Results

4.1 Evidence for a structural break

In this section we present the results and discuss their implications for forecasting German GDP. The time series of our interest are depicted in Figure 1. As seen around year 2001 the behavior of the time series somewhat changes, i.e. both the unconditional mean and variance seem to get smaller. At best this is seen for the annual and semi-annual growth rates and less for the quarterly growth rates.

In order to test this formally we have applied the Hansen (1997) test of structural break. The results

of this test are reported in Table 4. In addition Figure 3 displays inverted Likelihood Ratio (LR) test statistics used to construct the 95% confidence intervals for the timing of a break occurrence. As seen, the test statistics of the null hypothesis of no structural break is significant at the 1%, 5%, and 10% significance levels for $h = 1, 2, 4$, respectively. Thus, we find rather convincing statistical evidence for existence of a structural break in the unconditional mean and variance of the annual, and semi-annual growth rates of the German GDP, whereas the time series properties of the quarterly growth rates comparatively less informative in this respect.

Observe that the first quarter of 2001 indicates the time when the break has occurred for annual and quarterly growth rates, and the second quarter of 2001 for semi-annual growth rates. Since the constructed 95% confidence interval for semi-annual growth rates includes also the first quarter of 2001, we have imposed 2001:I as the uniform timing of the structural break for all types of growth rates considered here.

Table 5 reports the descriptive statistics of GDP growth rates for different time periods. First it is instructive to compare its values for the periods before the structural break and after, i.e. 1993:II - 2001:I and 2001:II – 2004:IV, respectively. As seen, the hypothesis of the existence of a structural break both in the unconditional mean and variance is confirmed as the values of the unconditional mean in the post-break period is at least 3 times smaller than that in the pre-break period. Similar conclusions are also valid for the unconditional variance.

Table 5 also reports the descriptive statistics for the whole forecast period (1998:I – 2004:IV) and the pre-break forecast period (1998:I – 2001:I). Observe that the values of the descriptive statistics for the latter period are very similar to the values obtained for the whole pre-break period. At the same time, values for the whole forecast period appear to be in between of those reported for the pre- and post-break forecast periods.

4.2 Out-of-sample forecast results: 1998:I – 2004:IV

Having determined the existence of the structural break in 2001:I, we evaluate the forecasting performance of the alternative leading indicators for the period 1998:I – 2004:IV. In doing so, we follow the other studies

to which we refer in Figure 2. As seen, all four studies depicted in the upper panel of this figure employ the forecast sample that includes the timing of the structural break. But none of this studies have taken his existence into account. We know about its existence but evaluating the forecasting performance over this time span allows us to obtain a benchmark that we can compare the results obtained for the pre- and post-break forecast periods with.

Tables 6 and 7 summarize our findings for the PcGets and the BIC model selection strategies for the recursive estimation method. The rolling method has produced almost uniformly inferior to the recursive method forecast accuracy and therefore in order to save the space we have opted not to report it in the paper but to make it available on request. The likely reason for such a result is a relatively small number of observations available for a rolling window. In addition, out of three approaches to model selection with PcGets (conservative, liberal, and expert) it seems that the former one has a slight edge over the remaining two but the overall difference in the forecast accuracy across these strategies seems to be rather minor. Thus, also in this case we have opted not to report the complete set of the results in the paper but to make it available on request.

Table 8 displays the seven indicators with most accurate forecasts according to the Root Mean Squared Error (RMSE) criterion. Observe that all RMSE entries in this table are expressed as ratio to the benchmark "NAIVE" model, whose forecast is the historical mean of the corresponding growth rates. We also report the Theil's U measure of forecast accuracy, see Theil (1966).

$$\textit{Theil's } U = \frac{\left[\sum_{i=1}^{28}(P_i - A_i)^2\right]^{0.5}}{\left[\sum_{i=1}^{28} A_i^2\right]^{0.5}}, \tag{2}$$

where P_i and A_i are the forecast and the actual values, respectively. It can be interpreted as the squared root of a sum of the squared forecast errors of the proposed forecasting model divided by the squared root of a sum of squared observed values, i.e. all forecast values are set to zero $P_i = 0$ for all $i = 1, ..., 28$. The Theil's U values lower than 1.0 show an improvement in forecast accuracy of the proposed forecasting model. As it will be shown below, reporting these two measures of forecast accuracy will allow to disclose ability of various alternative indicators forecast the German GDP growth rates in the pre- and post-break

periods.

Observe that Tables 6, 7, and 8 provide only point estimates of the RMSE and the Theil's U forecast accuracy measures. This allows only the qualitative judgement on the ranking of the models. Of course, it would be interesting and perhaps more informative to conduct a statistical test for equal forecast accuracy along the lines of Diebold and Mariano (1995) for non-nested models or of Clark and McCracken (2001) for nested models. We, however, have chosen not to do so for the following reasons. First of all, our forecast sample is rather small with only 28 observations. Hence, the power of these statistical tests is likely to be rather low for such a small number of observations. Second, our finding of the structural break, that effectively splits the forecast sample almost in halves, further reduces number of observations that are available for each of the pre- and post-break periods. Thus, the power of the tests for forecast accuracy is expected to be even lower when applied to the forecasts of each subsample separately. Third, since the test statistics (e.g. of Diebold and Mariano (1995)) is based on the asymptotic long-run covariance matrix of the forecast error differential, it is rather improbable that we are able to precisely estimate it with the number of observations that is slightly larger than a dozen in each forecast subsample. Fourth, the presence of the structural break also casts some doubts on whether the forecast error differential can be considered as the covariance stationary time series — another assumption that needs to be satisfied when performing the forecast accuracy tests.

The forecast results can be summarized as follows:

- Generally, the RMSE measured for the horizons of interest $h = 1, 2, 4$ is decreasing with the forecast horizon h. This indicates that when the forecasting time series is expressed at the annualized growth rates, the annual growth rates can be predicted with a greater accuracy using the year-on-year growth rates. This can be explained by the fact that the higher is the difference order the more persistent are the corresponding time series.

- Relative to the benchmark *NAIVE* model, none of the models offers a consistent improvement in forecast accuracy for all forecast horizons except for *FB1SA, DFB1SA, DFB1TC* for PcGets CON, *DFB1TC* for BIC for recursive scheme, for which the ratio relative to the benchmark is less than

unity.

- The forecasting performance of the models that use the first difference of the leading indicators is generally better than that of the models that use indicators in levels. The possible explanation is that the first differencing removes the persistence, which is characteristic to the indicators in levels, and thereby avoids the big swings in the forecasts that undermine the forecasting accuracy.

- The forecasting exercise using the rolling window has produced generally worse results that using the expanding window. This is rather surprising finding given the presence of the structural break in the middle of the forecast sample, since one of the arguments for using the rolling forecasting scheme over the recursive one is that in the presence of model parameter instability the former method would simply "roll" over the break. Such that the forecasts for the post-break period will be produced using an ever increasing share of observations and ultimately all observations from the post-break period. Our finding on the inferiority of the rolling window forecasts can be attributed to the fact that the size of the rolling window as well as the size of the post-break period have been rather small for the advantages of using the rolling forecasts to be realized. As in these circumstances the model parameters have been estimated with lower precision and the models themselves have been probably overfitted.

- Across the three different strategies employed by PcGets *Liberal, Expert* and *Conservative*, the former one has produced worse results than the latter one, and the *Expert* strategy is in between. Moreover, there is no noticeable improvement of the PcGets over the BIC selection strategy.

- Table 8 displays seven models with the lowest RMSE error. As seen, only at $h = 1$ and $h = 2$ the forecast gains of maximum 12.5% and of 13.9 % relative to the benchmark "NAIVE" model are realized. At $h = 4$ the forecast gains of maximum of 5.2% are realized for the PcGets strategy. Also, at the latter horizon there are much more models that fare worse forecast accuracy than the benchmark model.

- The Theil's U measure of forecast accuracy is lower than one in all reported cases in Table 8. This further confirms the results reported above.

4.3 Forecast results: 1998:I – 2001:I and 2001:II – 2004:IV

Given our knowledge on the existence of a structural break during the forecast period we have computed measures of forecast accuracy for the pre- and the post-break periods.

The results for the pre-break period 1998:I – 2001:I can be summarized as follows:

- There are much larger realized gains in the forecast accuracy of the leading indicator models against both benchmark models, i.e. NAIVE and no-change. The forecast gains relative the NAIVE model constitute around 15%, 25%, and 20% for $h = 1, 2, 4$, respectively.
- The diffusion index models exhibit the superior forecast accuracy relative to other model at all forecast horizon uniformly.
- The values of the Theil's U are also considerably lower than for those obtained for the whole forecast sample 1998:I – 2004:IV.

The results for the post-break period 1998:I - 2001:I can be summarized as follows:

- At the first glance, when comparing the forecast accuracy of the alternative leading indicator models with the benchmark NAIVE model, it is tempting to conclude that also for this forecast period the leading indicator models offer improvement in the forecast accuracy.
- However, a look at the corresponding values of the Theil's U measure reveals that this is not the case as its values are all above one. This indicates that all the leading indicator models perform much worse than a no-change model.
- The explantation to such contradictory conclusions with respect to the different benchmark models is that the leading indicator models (also including the "NAIVE" model) are unable to recognize sharp decline in the mean of the growth rates that took place in the first half of 2001. Consequently, all the forecasts, made with the help of this models, heavily rely on the past historical pre-break data where the unconditional mean is much higher than that in the post-break period, see Table 5. On the contrary, the forecast accuracy measure of Theil (1966) is not based on the historical data

but only on those that are available for a specified forecast sample. As a result, it is not prone to the detrimental consequences of occurrence of a structural break if it is correctly recognized.

5 Conclusions

In this paper we have undertaken a comparison of the forecasting ability of a wide number of alternative composite indicators. To this date, our study is the most comprehensive one in the terms of the number of the alternative leading indicators for Germany. We explore the forecasting properties of these indicators for the quarterly, semi-annual, and annual growth rates of the real German GDP over the period from 1998:I — 2004:IV. Incidently, during this period the dynamic behavior of the time series of interest drastically changes. The structural break takes place around the year of 2001, when the Germany economy slipped into the prolonged period of slump in the economic activity that is not over at the moment of writing this article. Consequently, it is of a great interest to investigate whether the so-called leading indicators were able to predict the upcoming stagnation in the German economy.

Our main finding is that none of the leading indicators were able to adequately react to the changes in the dynamic properties of the real German GDP. In the post-break period, all the forecasts generated from those models overestimate the growth rates of the reference time series. Nevertheless, we record the ability of some leading indicators (e.g. diffusion indices) to provide greater forecast accuracy over the benchmark models in the pre-break period.

Our study also highlights the importance of an appropriate measure of the forecast accuracy in the presence of a structural break that primarily affects an unconditional mean, that is often accompanied by changing unconditional variance, of the forecast time series. We have shown that in this case, the Theil's U forecast measure, that compares the forecast RMSE to the root mean square of the actual observations that belong to the forecast period, is more appropriate than the forecast measure calculated as the ratio of the forecast RMSE to that the NAIVE model or, equally, to that of any other model, where the forecasts are generated using all the available historical information without taking into account existence of a structural break. In our case, the Theil's U forecast measure is able to point out to the obvious worsening

of the forecast accuracy in the post-break period compared to that in the pre-break period. The latter forecast accuracy measure leads to erroneous conclusions.

We have investigated the forecasting properties of the leading indicators using the wide spread multi-step or dynamic forecasting approach first advocated in Stock and Watson (1999, 2002) and further employed in Forni et al. (2002) as well as Dreger and Schumacher (2004), among many others. Therefore our results should be considered conditional on this approach. Nevertheless, our study further contributes to the importance of structural breaks in forecasting and points out to the caveats of overlooking them as it seems to be the case in the previous research such as Hinze (2003), Mittnik and Zadrozny (2004), Dreger and Schumacher (2004) and Schumacher (2005) that addressed the similar question.

In our future research we intend to further investigate the properties of the leading indicators using non-linear models or applying the methods that could as early as possible to detect a structural change and therefore to exhibit robustness to its atrocious consequences, when these structural breaks are overlooked.

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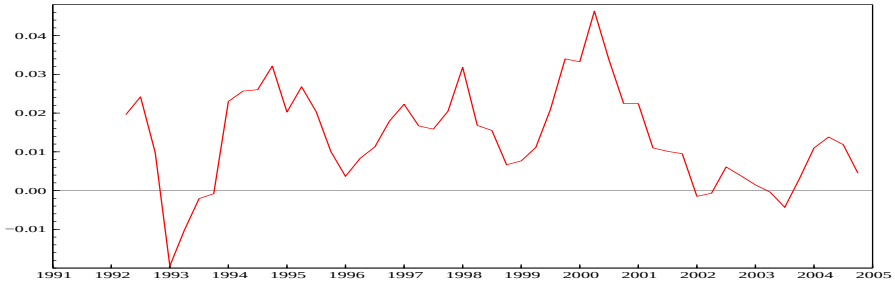
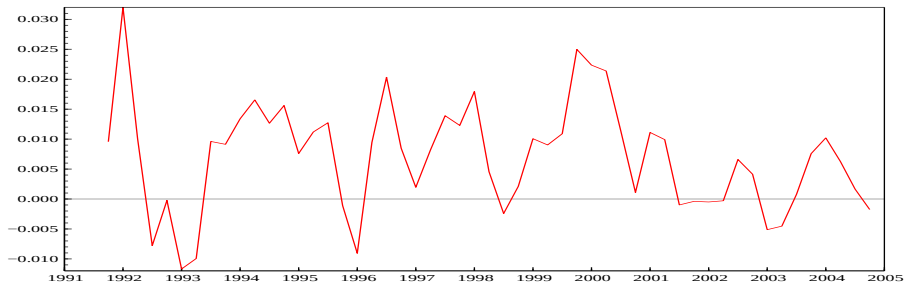
Appendix

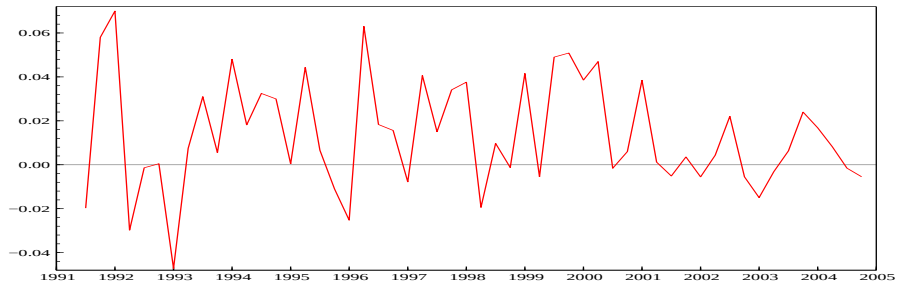
Figure 1: Real German GDP: annual, semi-annual, and quarterly growth rates



(a) y_t^4

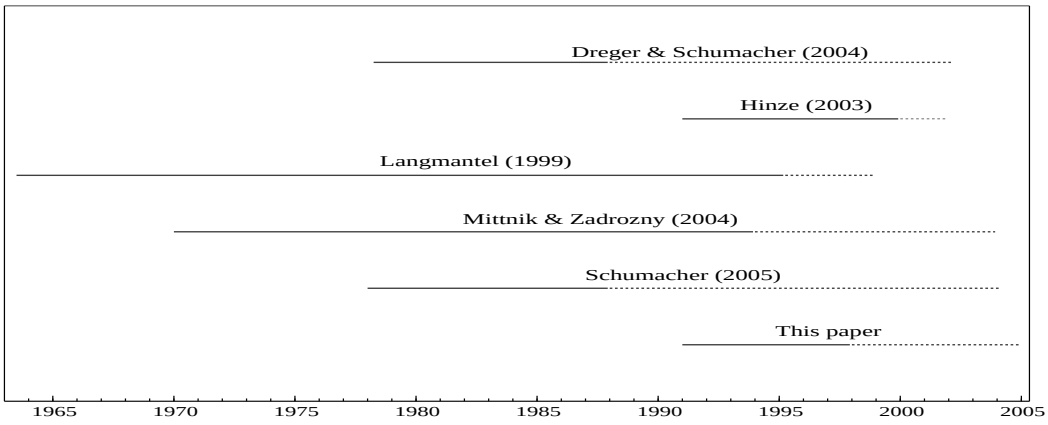


(b) y_t^2

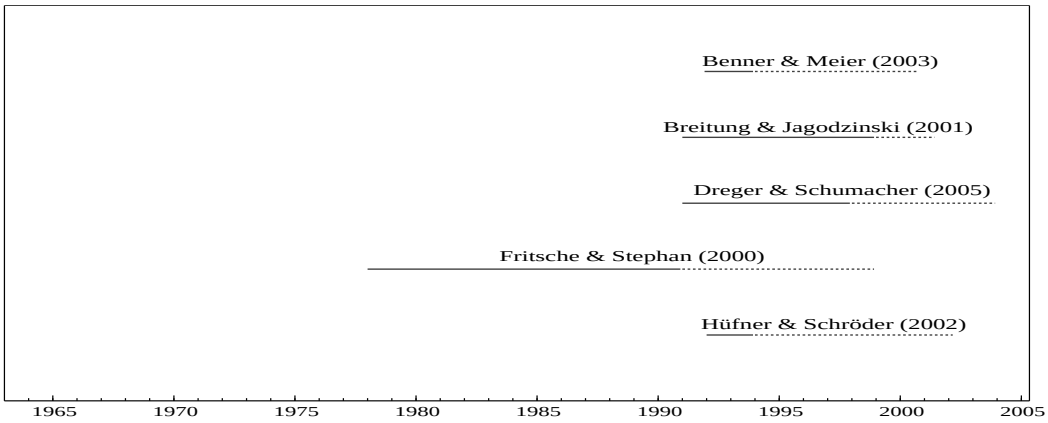


(c) y_t^1

Figure 2: Estimation (bold line) and forecast (dotted line) samples used in the literature for forecasting German GDP (upper panel) and industrial production (lower panel)

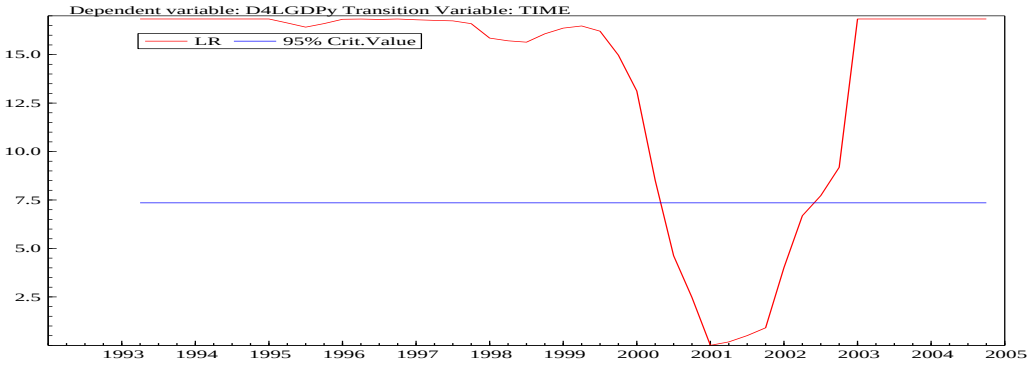


(a) German GDP

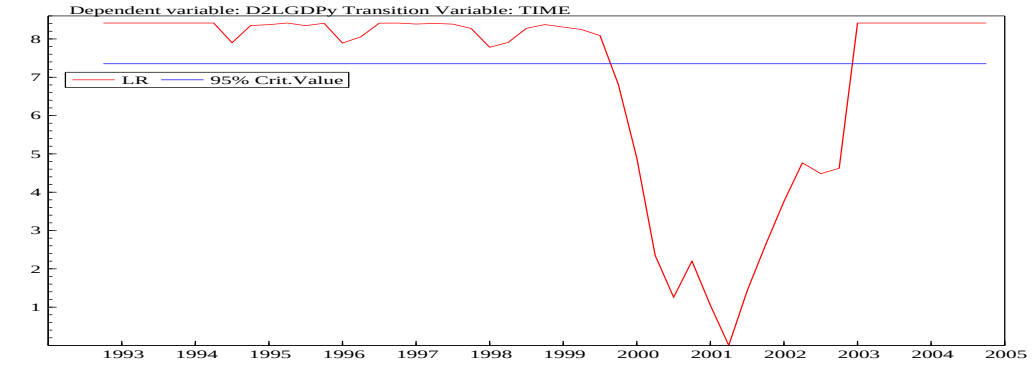


(b) German industrial production

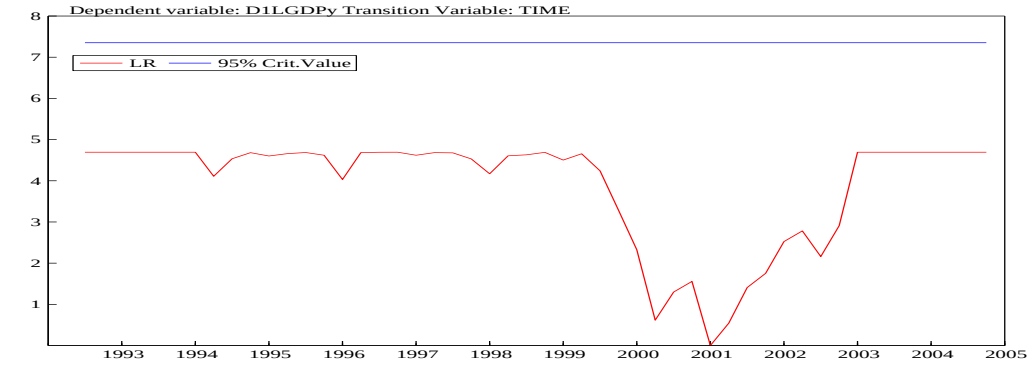
Figure 3: Hansen (1997): Confidence interval construction for threshold



(a) $D4$



(b) $D2$



(c) $D1$

Table 1: The list of component series of the diffusion index, 1991:1-2005:3

Umlauf festverzinslicher Wertpapiere von Emittenten mit Sitz in Deutschland

1. Umlauf inländischer Inhaberschuldverschreibungen / Hypothekenpfandbriefe WU0002
2. Umlauf inländischer Inhaberschuldverschreibungen / Öffentliche Pfandbriefe WU0010
3. Umlauf inländischer Inhaberschuldverschreibungen / Schuldverschreibungen von Spezialkreditinstituten WU0011
4. Umlauf inländischer Inhaberschuldverschreibungen / Sonstige Bankschuldverschreibungen WU0012
5. Umlauf inländischer Inhaberschuldverschreibungen / Industrieobligationen inländischer Emittenten WU0013
6. Umlauf inländischer Inhaberschuldverschreibungen / Anleihen der öffentlichen Hand WU0014
7. Umlauf inländischer Inhaberschuldverschreibungen / Bankschuldverschreibungen WU0015
8. Umlauf inländischer Inhaberschuldverschreibungen / Insgesamt WU0016
9. Umlauf von unter inländischer Konsortialführung begebenen DM/Euro-Auslandsanleihen WU0044

Renditen und Indizes deutscher Wertpapiere

10. Umlaufsrenditen inländischer Inhaberschuldverschreibungen / Anleihen der öffentlichen Hand WU0004
11. Umlaufsrenditen inländischer Inhaberschuldverschreibungen / Insgesamt WU0017
12. Umlaufsrenditen inländischer Inhaberschuldverschreibungen / Hypothekenpfandbriefe WU0018
13. Umlaufsrenditen inländischer Inhaberschuldverschreibungen Kommunalobligationen = Öffentliche Pfandbriefe (MD) WU0019
14. CDAX-Kursindex (=Monatsendstände) / Basis: Ultimo 1987 = 100 WU001A
15. Umlaufsrenditen inländischer Inhaberschuldverschreibungen / Industrieobligationen WU0022
16. Umlaufsrenditen von unter inländischer Konsortialführung begebenen DM-/Euro-Auslandsanleihen WU0024
17. Umlaufsrenditen inländischer Inhaberschuldverschreibungen / Börsennotierte Bundeswertpapiere (=Monatsdurchschnitte) WU0115
18. Deutscher Rentenindex (REX) / Monatsendstände WU035A
19. Umlaufsrenditen inländischer Inhaberschuldverschreibungen / Bankschuldverschreibungen WU1032
20. DAX-Index (=Monatsendstände) / Basis: Ultimo 1987 = 1000 / Rückwärts verknüpft mit d. Zeitreihe des Index d. Börsen-Zeitung WU3141
21. Umlaufsrenditen inl. Inhaberschuldverschr. / Bankschuldverschr./ Mittlere RLZ von über 9 bis einschl. 10 Jahren / Monatswerte WU8616
22. Ungewogene Umlaufsrendite der an der Eurex jeweils lieferb. Bundeswertpapiere mit Restlaufzeiten von üb. 9 bis 10 Jahren WX3950

Absatz und Erwerb von Investmentzertifikaten in Deutschland

23. Mittelaufkommen inländischer Publikumsfonds / Offene Immobilienfonds WU0040
24. Mittelaufkommen inländischer Publikumsfonds WU0113
25. Mittelaufkommen inländischer Spezialfonds WU0166
26. Netto-Erwerb bzw. Netto-Veräußerung (−) ausländischer Investmentanteile durch Inländer zu Transaktionswerten WU0167
27. Absatz (=Erwerb) in- und ausländischer Investmentzertifikate insgesamt WX4215
28. Absatz von inländischen Investmentzertifikaten (Mittelaufkommen) WX4216
29. Erwerb in- und ausländischer Investmentzertifikate durch Inländer WX4217
30. Erwerb ausländischer Investmentzertifikate durch inländische Kreditinstitute (einschl. Bausparkassen) WX4220
31. Erwerb ausländischer Investmentzertifikate durch inländische Nichtbanken WX4223
32. Netto-Erwerb bzw. Netto-Veräußerung inländischer Investmentzertifikate durch Ausländer zu Transaktionswerten WX4225
33. Erwerb in- und ausländ. Investmentzertifikate durch inländische Kreditinstitute (einschl.Bauspark.) WX4226
34. Erwerb in- und ausländischer Investmentzertifikate durch inländische Nichtbanken WX4228

35. Mittelaufkommen inländischer Publikumsfonds / Wertpapierfonds WX9727 Produktion im Produzierenden Gewerbe (arbeitstäglich bereinigt)
36. D-Ges / Produktion / arbeitstäglich bereinigt / C – F Produzierendes Gewerbe UXNA01
37. D-Ges / Produktion / arbeitstäglich bereinigt / Vorleistungsgüterproduzenten UXNA04
38. D-Ges / Produktion / arbeitstäglich bereinigt / Investitionsgüterproduzenten UXNA05
39. D-Ges / Produktion / arbeitstäglich bereinigt / Gebrauchsgüterproduzenten UXNA06
40. D-Ges / Produktion / arbeitstäglich bereinigt / Verbrauchsgüterproduzenten UXNA07
41. D-Ges / Produktion / arbeitstäglich bereinigt / DG/24 Chemische Industrie UXNA25
42. D-Ges / Produktion / arbeitstäglich bereinigt / DJ27 Metallerzeugung u -bearbeitung UXNA33
43. D-Ges / Produktion / arbeitstäglich bereinigt / DK29 Maschinenbau UXNA39
44. D-Ges / Produktion / arbeitstäglich bereinigt / DM34 H v Kraftwagen u Kraftwagenteilen UXNA50
45. D-Ges / Produktion / arbeitstägl bereinigt / Bauhauptgewerbe / 45.1+2 / Vorbereitende Baustellenarbeiten, Hoch- u Tiefbau UXNA61
46. D-Ges / Produktion / arbeitstäglich bereinigt / E Energie UXNI61
47. D-Ges / Produktion / arbeitstäglich bereinigt / Industrie UXNI63

Konjunkturlage / Auftragseingang in der Industrie (arbeitstäglich bereinigt)

48. D-Ges / Auftragseingang / Werte / Gesamt / DB-DN Verarbeitendes Gewerbe / arbeitstäglich bereinigt UXA001
49. D-Ges / Auftragseingang / Werte / Gesamt / Vorleistungsgüterproduzenten / arbeitstäglich bereinigt UXA004
50. D-Ges / Auftragseingang / Werte / Gesamt / Investitionsgüterproduzenten / arbeitstäglich bereinigt UXA007
51. D-Ges / Auftragseingang / Werte / Gesamt / Gebrauchsgüterproduzenten / arbeitstäglich bereinigt UXA010
52. D-Ges / Auftragseingang / Werte / Gesamt / Verbrauchsgüterproduzenten / arbeitstäglich bereinigt UXA013
53. D-Ges / Auftragseingang / Werte / Gesamt / Konsumgüterproduzenten / arbeitstäglich bereinigt UXA742
54. D-Ges / Auftragseingang / Werte / arbeitstäglich bereinigt / Bauhauptgewerbe UXDA01
55. D-Ges / Auftragseingang / Werte / arbeitstäglich bereinigt / Wohnungsbau UXDA03
56. D-Ges / Auftragseingang / Werte / arbeitstäglich bereinigt / Hoch- u Tiefbau Gewerbliche Auftraggeber (einschl Bahn u Post) UXDA31
57. D-Ges / Auftragseingang / Werte / Hoch- u Tiefbau Öffentl Auftraggeber (ohne Bahn u Post) / + Straßenb / arbeitst berein UXDA32 Einzelhandelsumsätze (kalenderbereinigt)
58. Einzelhandel / Umsatz / Werte / kalenderbereinigt / 52 insgesamt / ohne Handel mit KfZ u ohne Tankstellen UXHJ45
59. Einzelhandel / Umsatz / Werte / kalenderbereinigt / Einzelhandel zuzügl Einzelhandel mit KfZ u zuzügl Tankstellen UXHJ87
60. Einzelhandel / Umsatz / Volumen / kalenderbereinigt / 52 insgesamt / ohne Handel mit KfZ u ohne Tankstellen UXHK45
61. Einzelhandel / Umsatz / Volumen / kalenderbereinigt / Einzelhandel zuzügl Einzelhandel mit KfZ u zuzügl Tankstellen UXHK87

Arbeitsmarkt

62. D-GES / Erwerbstätige nach ESVG'95 1) / Im Inland / Monatsdurchschnitte UUBA14
63. D-GES / Arbeitslose / insgesamt / Monatsendstände / UUCC01
64. D-GES / Offene Stellen / Insgesamt / Monatsendstände UUCC04
65. D-GES / Kurzarbeiter / Insgesamt / Teilnehmerbestand (Stand: Monatsmitte) UUCC05
66. D-GES / Monatsbericht im Bauhauptgewerbe (WZ93) 1) / Beschäftigte / insgesamt / alle Betriebe UUMB01
67. D-GES / Beschäftigte / Betriebe (MB) / Bergbau,Gew.v.Steinen u.Erden,Verarbeitendes Gewerbe UUOA01

Verbraucherpreisindex

68. D-GES / Verbraucherpreisindex / Originalwerte / Insgesamt UUFA01
69. D-GES / Verbraucherpreisindex / Originalwerte / 011 Nahrungsmittel UUFA03

70. D-GES / Verbraucherpreisindex / Originalwerte / Wohnungsmieten (netto) und Wohnungsnebenkosten UUFB61
71. D-GES / Verbraucherpreisindex / Originalwerte / Energie UUFB75

Andere Preisindizes

72. D-GES / Erzeugerpreise landw. Produkte / Originalwerte / Insgesamt (ohne Umsatzsteuer) UUGA01
73. D-GES / Erzeugerpr.gewerbl.Prod. (Inlandsabsatz) / Originalw./ Insgesamt UUZF01
74. D-GES / Einfuhrpreise / Originalwerte / Insgesamt UUZI01
75. D-GES / Ausfuhrpreise / Originalwerte / Insgesamt UUZJ01
76. HWWA-Rohstoffpreisindex "Euroland" / Gesamtindex ohne Energie -auf Euro-Basis- YU0516
77. HWWA-Rohstoffpreisindex "Euroland" / Energierohstoffe -auf Euro-Basis- YU0517

Wichtige Posten der Zahlungsbilanz

78. Warenhandel / Außenhandel / Ausfuhr (fob) EU2001
79. Dienstleistungsverkehr / Insgesamt / Einnahmen EU2100
80. Warenhandel / Außenhandel / Einfuhr (cif) EU3001
81. Dienstleistungsverkehr / Insgesamt / Ausgaben EU3100
82. Erwerbs- und Vermögenseinkommen / Insgesamt / Ausgaben EU3170
83. Warenhandel / Außenhandel / Saldo EU4001
84. Warenhandel / Saldo der Ergänzungen EU4006
85. Dienstleistungsverkehr / Insgesamt / Saldo EU4100
86. Erwerbs- und Vermögenseinkommen / Insgesamt / Saldo EU4170
87. Laufende Übertragungen / Insgesamt / Saldo EU4220
88. Langfristiger Kapitalverkehr / langfristiger Kreditverkehr der Kreditinstitute /insgesamt EU4395
89. Kurzfristiger Kreditverkehr / Kreditinstitute / insgesamt / Saldo EU4510
90. Lang- und kurzfristiger Kapitalverkehr / Kreditverkehr und übriger Kapitalverkehr / Saldo EU4626
91. Saldo der Leistungsbilanz EU4710
92. Saldo der nicht aufgliederbaren Transaktionen (Restposten) EU4720
93. Ausfuhr / Werte / insgesamt / saisonbereinigt XS5600
94. Einfuhr / Werte / insgesamt / saisonbereinigt XS5601
95. Außenhandelssaldo / Werte / insgesamt / saisonbereinigt XS5602

Erwerbs- und Vermögenseinkommen — Insgesamt

96. Erwerbseinkommen / Insgesamt / Einnahmen EU2151
97. Vermögenseinkommen / Für Dividenden / Einnahmen EU2152
98. Vermögenseinkommen / Erträge aus Investmentzertifikaten / Einnahmen EU2153
99. Vermögenseinkommen / Zinsen für Anleihen / Einnahmen EU2154
100. Vermögenseinkommen / Für Wertpapiere / zusammen / Einnahmen EU2156
101. Vermögenseinkommen / Für Direktinvestitionen / zusammen / Einnahmen EU2164
102. Vermögenseinkommen / Zinsen für Kredite / zusammen / Einnahmen EU2168
103. Vermögenseinkommen / Insgesamt / Einnahmen EU2169
104. Erwerbs- und Vermögenseinkommen / Insgesamt / Einnahmen EU2170
105. Erwerbseinkommen / Insgesamt / Ausgaben EU3151
106. Vermögenseinkommen / Für Dividenden / Ausgaben EU3152

107. Vermögenseinkommen / Zinsen für Anleihen / Ausgaben EU3154
108. Vermögenseinkommen / Zinsen für öffentliche Anleihen / Ausgaben EU3155
109. Vermögenseinkommen / Für Wertpapiere / zusammen / Ausgaben EU3156
110. Vermögenseinkommen / Für Direktinvestitionen / zusammen / Ausgaben EU3164
111. Vermögenseinkommen / Zinsen für Kredite / zusammen / Ausgaben EU3168
112. Vermögenseinkommen / Insgesamt / Ausgaben EU3169
113. Erwerbseinkommen / Insgesamt / Saldo EU4151
114. Vermögenseinkommen / Insgesamt / Saldo EU4169

Laufende Übertragungen/Vermögensübertragungen

115. Laufende Übertragungen / Öffentlich / Europäische Gemeinschaften / fremde Leistungen EU2201
116. Laufende Übertragungen / Öffentl. Übertr. / Steuereinnahmen EU2203
117. Laufende Übertragungen / Öffentl. Übertr. / insgesamt / fremde Leistungen EU2210
118. Laufende Übertragungen / Priv. Übertr. / Renten, Pensionen, Unterstütz. / fremde Leist. EU2211
119. Laufende Übertragungen / Private Übertr. / insgesamt / fremde Leistungen EU2215
120. Laufende Übertragungen / Insgesamt / fremde Leistungen EU2220
121. Vermögensübertragungen / Private Übertr. / insgesamt / fremde Leistungen EU2553
122. Vermögensübertragungen / Insgesamt / fremde Leistungen EU2555
123. Laufende Übertragungen / Öffentlich / Europäische Gemeinschaften / eigene Leistungen EU3201
124. Laufende Übertragungen / Öffentlich / Übrige intern. Organisationen / eigene Leistungen EU3202
125. Laufende Übertragungen / Öffentl. Übertr. / Steuererstattungen EU3203
126. Laufende Übertragungen / Öffentl. Übertr. / Zuwendungen an Entw.-Ldr. / eigene Leist. EU3204
127. Laufende Übertragungen / Öffentl. Übertr. / Renten, Pensionen, Unterstütz. / eig. Leist. EU3205
128. Laufende Übertragungen / Öffentl. Übertr. / insgesamt / eigene Leistungen EU3210
129. Laufende Übertragungen / Priv. Übertr. / Renten, Pensionen, Unterstütz. / eigene Leist. EU3211
130. Laufende Übertragungen Private Übertr. / insgesamt / eigene Leistungen EU3215
131. Laufende Übertragungen / Insgesamt / eigene Leistungen EU3220
132. Vermögensübertragungen / Öffentl. Übertr. / insgesamt / eigene Leistungen EU3551
133. Vermögensübertragungen / Insgesamt / eigene Leistungen EU3555
134. Laufende Übertragungen / Öffentlich / insgesamt / Saldo EU4210
135. Laufende Übertragungen / Privat / insgesamt / Saldo EU4215

Wechselkurse / Effektive Wechselkurse des Euro

136. Indikator der preisl.Wettbewerbsfähigkeit d.deutschen Wirtschaft gegenüber 19 Industrieländern / auf Basis der Verbraucherpreise YX900D

Zinssätze / Geldmarktsätze / Geldmarktsätze nach Monaten

137. Geldmarktsätze am Frankfurter Bankplatz / Tagesgeld / Monatsdurchschnitt SU0101
138. Geldmarktsätze am Frankfurter Bankplatz / Tagesgeld / Niedrigstsatz im Monat SU0102
139. Geldmarktsätze am Frankfurter Bankplatz / Tagesgeld / Höchstsatz im Monat SU0103
140. Geldmarktsätze am Frankfurter Bankplatz / Monatsgeld / Monatsdurchschnitt SU0104
141. Geldmarktsätze am Frankfurter Bankplatz / Dreimonatsgeld / Monatsdurchschnitt SU0107
142. Geldmarktsätze am Frankfurter Bankplatz / Dreimonatsgeld / Niedrigstsatz im Monat SU0108
143. Geldmarktsätze am Frankfurter Bankplatz / Dreimonatsgeld / Höchstsatz im Monat SU0109
144. Geldmarktsätze am Frankfurter Bankplatz / Sechsmonatsgeld / Monatsdurchschnitt SU0250
145. Geldmarktsätze am Frankfurter Bankplatz / Zwölfmonatsgeld / Monatsdurchschnitt SU0253

Table 2: The alternative leading indicators

Provider	Indicator	Space	Notation	Time span
CEPR[1]	EuroCOIN	Euro Area	EuroCOIN	1988:1–2004:12
Commerzbank[2]	Early Bird indicator	Germany	EalyBird	1992:1–2004:12
Deutsche Bundesbank[3]	Interest rate spreads:			
	SU0253 minus SU0101	Germany	SPREAD1SU	1991:1–2004:12
	SU0253 minus SU0104	Germany	SPREAD2SU	1991:1–2004:12
	WX4271 minus SU0101	Germany	SPREAD1WX	1991:1–2004:12
	WX4271 minus SU0104	Germany	SPREAD2WX	1991:1–2004:12
	WU8616 minus SU0101	Germany	SPREAD1WU	1991:1–2004:12
	WU8616 minus SU0104	Germany	SPREAD2WU	1991:1–2004:12
European Commission[4]	Consumer confidence indicator	European Union	EU99	1985:1–2004:12
	Consumer confidence indicator	Euro Area	EA99	1985:1–2004:12
	Consumer confidence indicator	Germany	DE99	1985:1–2004:12
	Economic sentiment indicator	European Union	EUESI	1985:1–2004:12
	Economic sentiment indicator	Euro Area	EAESI	1985:1–2004:12
	Economic sentiment indicator	Germany	DEESI	1985:1–2004:12
GfK[5]	Konsumklima indicator	Germany	Konsumklima	1993:1–2004:12
Handelsblatt[6]	Handelsblatt indicator	Germany	HB	1993:2–2004:12
HypoVereinsbank[7]	R-Wort indicator	Germany	RWort	1993:1–2004:12
	S-Wort indicator	Germany	SWort	1993:1–2004:12
Ifo[8]	Geschäftsklima (R1)	Germany	IfoR1	1991:1–2004:12
	Geschäftsbeurteilung (R2)	Germany	IfoR2	1991:1–2004:12
	Geschäftserwartungen (R3)	Germany	IfoR3	1991:1–2004:12
IfW[9]	FAZ-Indikator	Germany	FAZ	1978:2–2004:12
NTC Research[10]	Purchasing Manager's index (manufacturing)	Germany	PMI	1996:2–2004:12
OECD[11]	Composite Leading Indicator	Euro Area	OECDcycleEA	1961:1–2004:12
	Composite Leading Indicator	Germany	OECDcycleDE	1961:1–2004:12
	Consumer confidence indicator	Germany	OECDconsumerSent	1986:1–2004:12
	Business confidence indicator (manufacturing)	Germany	OECDmanufConf	1986:1–2004:12
Own calculations	Diffusion indices:			
	Balanced panel SA index	Germany	FB1SA	1991:2-2004:12
	Total panel SA index	Germany	FT1SA145	1991:2-2004:12
	Balanced panel trend+cycle index	Germany	FB1TC	1991:2-2004:12
	Total panel trend+cycle index	Germany	FT1TC145	1991:2-2004:12
ZEW[12]	Indicator of economic sentiment	Germany	ZEW	1991:4–2004:12

[1] *Centre for Economic Policy Research* (http://www.cepr.org/data/Eurocoin/download/);
[2] *Commerzbank* (https://www.commerzbank.de/research/economic_research/index.html);
[3] *Deutsche Bundesbank* (http://www.bundesbank.de/statistik/statistik_zeitreihen.php);
[4] *European Commission* (http://europa.eu.int/comm/economy_finance/indicators/business_consumer_surveys/bcsseries_en.htm);
[5] *Gesellschaft für Konsum* (http://www.gfk.de/index.php?lang=de&contentpath=http%3A//www.gfk.de/produkte/statisch/studien/produkt_1_2_4_468.php);
[6] *Handelsblatt* (http://www.handelsblatt.com);
[7] *HypoVereinsbank* (http://www.hypovereinsbank.de);
[8] *Institut für Wirtschaftsforschung* (http://www.cesifo-group.de/portal/page?_pageid=36,34759&_dad=portal&_schema=PORTAL);
[9] *Institut für Weltwirtschaft in Kiel* (http://www.uni-kiel.de/ifw/home.htm);
[10] *NTC Research* (http://www.ntc-research.com/);
[11] *Organization for Economic Cooperation and Development* (http://www.oecd.org/document/43/0,2340,en_2825_293564_34858731_1_1_1_1,00.html);
[12] *Zentrum für Europäische Wirtschaftsforschung* (ftp://ftp.zew.de/pub/zew-docs/div/konjunktur.xls);

Table 3: Leading indicators used in the various studies that forecast German economic activity

	German real GDP						German index of industrial production				
Indicator	Dreger & Schumacher (2004)	Hinze (2003)	Langmantel (1999)	Mittnik & Zadrozny (2004)	Schumacher (2005)	This paper	Benner & Meier (2003)	Breitung & Jagodzinski (2001)	Dreger & Schumacher (2005)	Fritsche & Stephan (2000)	Hüfner & Schröder (2002a, 2002b)
EuroCOIN (EA)						+					
Early Bird (DE)		+				+	+	+	+		
Interest rates (DE)										+	
Interest rate spreads (DE)						+				+	
New orders (DE)										+	
Confidence indicator (EU)						+					
Confidence indicator (EA)						+					
Confidence indicator (DE)						+					
Economic sentiment indicator (EU)		+				+					
Economic sentiment indicator (EA)						+					
Economic sentiment indicator (DE)						+					+
Konsumklima (DE)						+					
HB (DE)		+				+		+	+		
R-Wort indicator (DE)						+		+			
S-Wort indicator (DE)						+					
Ifo indicators (DE)	+	+	+	+		+	+	+	+	+	+
FAZ (DE)						+		+	+		
PMI for manufacturing (DE)						+					+
OECD's CLI (EA)		+				+					
OECD's CLI (DE)						+					
OECD's consumer confidence (DE)						+				+	
OECD's business confidence (DE)						+					
Diffusion index (DE)	+				+	+					
ZEW (DE)		+				+	+	+	+		+

Table 4: Hansen (1997) linearity test

	Qhat	95% confidence interval Lower	Upper	P-value
D4	2001:I	2000:III	2002:IV	0.0016
D2	2001:II	1999:IV	2003:II	0.0208
D1	2001:I	nan	nan	0.0914

Table 5: Descriptive statistics for forecasted variables

	1993:II - 2001:I		1998:I - 2004: IV		1998:I - 2001: I		2001: II - 2004:IV	
	Mean	St. Dev.	Mean	St. Dev.	Mean	St. Dev.	Mean	St. Dev.
D4LGDPy	0.0185	0.0120	0.0137	0.0128	0.0233	0.0119	0.0053	0.0057
D2LGDPy	0.0192	0.0164	0.0127	0.0162	0.0222	0.0172	0.0045	0.0098
D1LGDPy	0.0205	0.0230	0.0120	0.0208	0.0224	0.0247	0.0030	0.0110

Table 6: RMSE Recursive PcGets CON

	1998:I - 2004:IV			1998:I - 2001:I			2001:II - 2004:IV		
	h=1	h=2	h=4	h=1	h=2	h=4	h=1	h=2	h=4
EuroCOIN	1.051	0.962	0.988	1.051	0.807	0.917	1.051	1.136	1.055
DEuroCOIN	1.027	0.947	0.974	0.942	0.895	0.890	1.181	1.013	1.050
EarlyBird	1.096	1.193	1.096	1.056	1.063	0.828	1.175	1.345	1.310
DEarlyBird	1.064	1.136	1.100	0.990	1.016	0.837	1.200	1.278	1.310
SPREAD1SU	1.004	1.023	1.126	1.013	1.074	1.119	0.984	0.951	1.132
DSPREAD1SU	0.957	0.917	1.036	0.934	0.892	1.000	1.002	0.950	1.072
SPREAD2SU	0.999	1.025	1.041	1.051	1.056	1.019	0.885	0.981	1.062
DSPREAD2SU	0.987	0.901	1.017	0.985	0.849	1.000	0.990	0.967	1.034
SPREAD1WX	1.044	0.994	1.045	1.064	0.932	1.058	1.000	1.072	1.031
DSPREAD1WX	1.000	1.075	1.044	1.000	1.042	1.092	1.000	1.118	0.995
SPREAD2WX	1.000	1.004	1.030	1.000	0.950	1.039	1.000	1.071	1.021
DSPREAD2WX	1.000	1.072	1.009	1.000	1.086	1.018	1.000	1.053	0.999
SPREAD1WU	1.000	0.987	1.072	1.000	0.933	1.103	1.000	1.054	1.039
DSPREAD1WU	1.000	1.058	0.989	1.000	1.047	0.997	1.000	1.073	0.981
SPREAD2WU	1.000	0.989	1.031	1.000	0.952	1.042	1.000	1.037	1.020
DSPREAD2WU	1.000	1.060	1.000	1.000	1.084	1.010	1.000	1.027	0.990
EU99	0.975	1.087	1.235	1.000	1.144	1.343	0.921	1.008	1.117
DEU99	0.959	0.964	1.063	1.000	1.079	1.094	0.869	0.785	1.031
EA99	0.989	1.023	1.300	1.000	1.013	1.462	0.967	1.035	1.116
DEA99	0.966	1.043	1.096	1.000	1.127	1.124	0.894	0.920	1.069
DE99	1.000	1.149	1.106	1.000	1.251	1.097	1.000	0.998	1.114
DDE99	1.000	1.035	1.161	1.000	1.034	1.268	1.000	1.037	1.044
EUESI	0.993	1.105	1.208	1.000	1.159	1.182	0.977	1.029	1.233
DEUESI	0.958	0.922	1.151	1.000	0.977	1.167	0.865	0.842	1.135
EAESI	1.002	1.125	1.257	1.000	1.148	1.270	1.006	1.094	1.243
DEAESI	0.994	1.016	1.168	1.031	1.140	1.214	0.915	0.823	1.121
DEESI	1.000	1.190	1.211	1.000	1.301	1.287	1.000	1.023	1.131
DDEESI	1.014	1.006	1.132	1.032	1.120	1.206	0.975	0.831	1.053
Konsumklima	nan	nan	nan	nan	nan	nan	1.133	1.120	1.218
DKonsumklima	nan	nan	nan	nan	nan	nan	1.090	1.206	1.065
HB	nan	nan	nan	nan	nan	nan	1.090	1.260	1.281
DHB	nan	nan	nan	nan	nan	nan	1.089	1.082	1.180
Rword	nan	nan	nan	nan	nan	nan	1.133	1.120	1.246
DRword	nan	nan	nan	nan	nan	nan	1.090	1.079	1.243
Sword	nan	nan	nan	nan	nan	nan	1.117	1.086	2.165
DSword	nan	nan	nan	nan	nan	nan	1.090	1.095	1.063
IfoR1	1.032	1.029	1.197	1.029	1.064	1.149	1.039	0.979	1.242
DIfoR1	0.981	0.888	1.050	1.037	0.891	1.047	0.855	0.884	1.052
IfoR2	1.062	1.279	1.295	1.059	1.271	1.287	1.070	1.290	1.302
DIfoR2	1.021	1.038	1.095	1.022	1.071	1.129	1.020	0.993	1.060
IfoR3	0.977	1.072	1.115	1.057	1.098	1.105	0.788	1.037	1.125
DIfoR3	0.964	0.922	1.022	0.974	0.886	1.004	0.944	0.967	1.041
FAZ	1.324	1.243	1.323	1.467	1.301	1.532	0.966	1.161	1.076
DFAZ	1.253	1.111	1.109	1.320	1.075	1.135	1.104	1.157	1.082
PMIindex	nan	nan	nan	nan	nan	nan	1.416	1.622	nan
DPMIindex	nan	nan	nan	nan	nan	nan	1.170	1.418	nan
OECDcycleEA	0.971	1.059	1.094	0.997	0.812	0.983	0.916	1.317	1.195
DOECDcycleEA	1.023	0.882	1.028	1.028	0.830	0.927	1.013	0.945	1.119
OECDcycleGer	1.091	1.179	1.052	1.070	1.180	0.898	1.133	1.177	1.185
DOECDcycleGer	1.017	1.153	1.132	0.986	0.899	0.982	1.077	1.422	1.263
OECDConsumerSent	1.000	1.137	1.228	1.000	1.221	1.332	1.000	1.014	1.114
DOECDConsumerSent	1.000	1.063	1.158	1.000	1.077	1.263	1.000	1.045	1.043
OECDManufConf	1.000	1.185	1.101	1.000	1.271	1.185	1.000	1.061	1.011
DOECDManufConf	1.028	1.026	1.100	1.000	1.094	1.146	1.083	0.927	1.051
FB1SA	0.948	0.936	0.981	1.008	0.855	0.903	0.813	1.035	1.053
DFB1SA	1.024	0.964	0.969	0.949	0.970	0.893	1.163	0.956	1.039
FT1SA145	0.893	0.987	1.012	0.930	0.874	0.991	0.813	1.120	1.032
DFT1SA145	0.997	0.972	0.974	0.935	0.969	0.913	1.114	0.976	1.032
FB1TC	1.010	0.979	1.153	0.900	0.675	1.009	1.203	1.274	1.280
DFB1TC	0.978	0.950	0.977	0.841	0.802	0.780	1.211	1.118	1.139
FT1TC145	0.998	1.113	1.146	0.918	0.739	0.916	1.144	1.469	1.335
DFT1TC145	1.064	0.996	1.019	0.936	0.818	0.741	1.287	1.192	1.235
ZEW	0.976	1.082	1.097	1.019	1.067	0.978	0.884	1.101	1.204
DZEW	1.020	1.053	1.133	0.974	0.949	1.108	1.107	1.176	1.158
NAIVE	0.021	0.017	0.013	0.025	0.018	0.014	0.016	0.015	0.013

Table 7: RMSE Recursive BIC

	1998:I - 2004:IV			1998:I - 2001:I			2001:II - 2004:IV		
	h=1	h=2	h=4	h=1	h=2	h=4	h=1	h=2	h=4
EuroCOIN	0.979	1.030	1.000	0.857	0.875	0.939	1.189	1.206	1.056
DEuroCOIN	0.975	0.921	0.965	0.942	0.814	0.870	1.038	1.046	1.052
EarlyBird	1.061	1.051	1.092	1.001	0.806	0.825	1.174	1.307	1.305
DEarlyBird	1.069	1.121	1.090	1.006	1.008	0.814	1.188	1.255	1.308
SPREAD1SU	0.955	0.969	1.071	0.942	0.973	1.138	0.980	0.965	1.000
DSPREAD1SU	0.957	0.901	1.070	0.934	0.863	1.111	1.002	0.950	1.028
SPREAD2SU	0.985	0.938	1.063	0.988	0.903	1.068	0.978	0.981	1.058
DSPREAD2SU	0.987	0.901	1.064	0.985	0.849	1.102	0.990	0.967	1.025
SPREAD1WX	1.029	0.989	1.090	1.039	0.980	1.136	1.010	1.001	1.042
DSPREAD1WX	1.029	1.001	1.064	1.055	1.012	1.135	0.973	0.986	0.989
SPREAD2WX	1.028	1.019	1.017	1.030	1.014	1.055	1.025	1.024	0.978
DSPREAD2WX	1.042	1.012	1.078	1.063	1.020	1.156	1.000	1.001	0.994
SPREAD1WU	1.026	0.990	1.087	1.026	0.993	1.142	1.028	0.987	1.030
DSPREAD1WU	1.045	0.989	1.081	1.064	0.996	1.165	1.005	0.980	0.992
SPREAD2WU	1.037	1.007	1.086	1.044	1.004	1.136	1.022	1.010	1.034
DSPREAD2WU	1.022	1.032	1.061	1.033	1.024	1.129	1.000	1.043	0.988
EU99	0.992	1.009	1.218	1.000	1.007	1.403	0.974	1.012	1.000
DEU99	0.976	1.003	1.081	1.066	1.084	1.175	0.758	0.885	0.980
EA99	1.002	1.000	1.258	1.000	1.000	1.472	1.007	1.000	1.000
DEA99	1.015	1.017	1.087	1.101	1.085	1.167	0.810	0.918	1.000
DE99	1.000	1.000	1.311	1.000	1.000	1.563	1.000	1.000	1.000
DDE99	1.027	1.000	1.116	1.040	1.000	1.222	1.000	1.000	1.000
EUESI	0.995	0.924	1.143	1.000	0.980	1.106	0.984	0.845	1.177
DEUESI	0.948	0.924	1.116	0.997	0.980	1.108	0.838	0.842	1.125
EAESI	0.999	1.002	1.222	1.000	1.066	1.237	0.996	0.911	1.208
DEAESI	0.967	0.933	1.174	1.026	1.007	1.207	0.835	0.823	1.140
DEESI	0.999	1.078	1.222	1.000	1.161	1.348	0.996	0.955	1.082
DDEESI	1.007	1.009	1.105	1.091	1.132	1.161	0.809	0.819	1.047
Konsumklima	1.029	1.614	1.890	0.974	1.907	2.413	1.133	1.113	1.154
DKonsumklima	1.018	1.036	1.242	0.981	0.989	1.396	1.090	1.095	1.068
HB	nan	nan	nan	nan	nan	nan	1.090	1.095	1.294
DHB	nan	nan	nan	nan	nan	nan	1.089	1.082	1.063
Rword	1.029	1.072	1.064	0.974	1.034	1.039	1.133	1.120	1.089
DRword	1.018	1.046	1.032	0.981	0.966	0.915	1.090	1.144	1.136
Sword	1.010	0.975	1.669	0.974	1.022	0.952	1.078	0.910	2.157
DSword	1.138	1.024	1.008	1.160	0.966	0.944	1.090	1.096	1.068
IfoR1	0.953	0.950	1.166	1.015	0.928	1.101	0.810	0.979	1.227
DIfoR1	0.895	0.907	1.026	0.914	0.924	1.078	0.855	0.884	0.972
IfoR2	1.061	1.145	1.310	1.072	1.075	1.279	1.037	1.232	1.341
DIfoR2	1.019	1.016	1.049	1.042	1.033	1.092	0.970	0.993	1.005
IfoR3	1.041	0.959	1.058	1.137	0.981	0.995	0.809	0.928	1.117
DIfoR3	0.911	0.861	1.021	0.923	0.795	0.997	0.886	0.942	1.044
FAZ	1.218	1.248	1.241	1.309	1.272	1.513	1.009	1.215	0.894
DFAZ	1.254	1.152	1.136	1.331	1.066	1.084	1.080	1.257	1.186
PMIindex	nan	nan	nan	nan	nan	nan	1.344	1.733	2.270
DPMIindex	nan	nan	nan	nan	nan	nan	1.417	1.369	1.624
OECDcycleEA	0.951	0.968	1.074	0.938	0.759	0.994	0.979	1.191	1.148
DOECDcycleEA	0.904	0.896	1.016	0.918	0.857	0.900	0.875	0.945	1.119
OECDcycleGer	1.143	1.041	1.053	1.115	1.006	0.887	1.197	1.087	1.196
DOECDcycleGer	1.055	0.966	1.089	1.045	0.897	1.017	1.075	1.051	1.157
OECDConsumerSent	1.000	1.000	1.312	1.000	1.000	1.565	1.000	1.000	1.000
DOECDConsumerSent	1.016	1.000	1.114	1.024	1.000	1.219	1.000	1.000	1.000
OECDManufConf	1.000	1.020	1.146	1.000	1.058	1.171	1.000	0.967	1.121
DOECDManufConf	1.028	0.999	1.084	1.083	1.049	1.122	0.904	0.927	1.045
FB1SA	1.036	1.073	1.063	0.955	1.009	0.987	1.183	1.152	1.133
DFB1SA	0.881	0.934	1.092	0.835	0.916	1.027	0.969	0.956	1.153
FT1SA145	1.036	1.067	1.002	0.967	1.003	0.947	1.166	1.147	1.053
DFT1SA145	0.875	0.944	1.105	0.828	0.919	1.034	0.965	0.976	1.171
FB1TC	1.066	1.023	1.017	0.941	0.651	0.867	1.286	1.368	1.146
DFB1TC	0.991	0.914	0.948	0.930	0.738	0.753	1.105	1.105	1.109
FT1TC145	1.057	1.142	1.017	0.847	0.721	0.801	1.390	1.532	1.193
DFT1TC145	0.988	0.965	1.003	0.875	0.762	0.742	1.186	1.182	1.207
ZEW	1.032	1.126	1.140	1.097	1.155	1.079	0.884	1.087	1.197
DZEW	1.024	1.031	1.048	0.974	0.948	0.974	1.118	1.131	1.117
BIC	1.000	1.000	1.058	1.000	1.000	1.114	1.000	1.000	1.000
FIX	1.024	1.034	1.129	1.036	0.988	1.085	1.000	1.092	1.170
NAIVE	0.021	0.017	0.013	0.025	0.018	0.014	0.016	0.015	0.013

Table 8: RMSE Recursive: seven models with greatest forecast accuracy

h=1			h=2			h=4		
Indicator	Relative RMSE	Theil's U	Indicator	Relative RMSE	Theil's U	Indicator	Relative RMSE	Theil's U
1998:I - 2004:IV								
BIC								
DFT1SA145	0.875	0.769	DIfoR3	0.861	0.699	DFB1TC	0.948	0.690
DFB1SA	0.881	0.774	DOECDcycleEA	0.896	0.727	DEuroCOIN	0.965	0.702
DIfoR1	0.895	0.786	DSPREAD1SU	0.901	0.731	EuroCOIN	1.000	0.727
DOECDcycleEA	0.904	0.794	DSPREAD2SU	0.901	0.731	NAIVE	1.000	0.728
DIfoR3	0.911	0.800	DIfoR1	0.907	0.736	FT1SA145	1.002	0.729
DEUESI	0.948	0.833	DFB1TC	0.914	0.741	DFT1TC145	1.003	0.730
OECDcycleEA	0.951	0.836	DEuroCOIN	0.921	0.747	DSword	1.008	0.734
PcGets CON								
FT1SA145	0.893	0.785	DOECDcycleEA	0.882	0.715	DFB1SA	0.969	0.705
FB1SA	0.948	0.833	DIfoR1	0.888	0.720	DEuroCOIN	0.974	0.708
DSPREAD1SU	0.957	0.841	DSPREAD2SU	0.901	0.731	DFT1SA145	0.974	0.709
DEUESI	0.958	0.841	DSPREAD1SU	0.917	0.744	DFB1TC	0.977	0.711
DEU99	0.959	0.842	DIfoR3	0.922	0.748	FB1SA	0.981	0.714
DIfoR3	0.964	0.847	DEUESI	0.922	0.748	EuroCOIN	0.988	0.719
DEA99	0.966	0.849	FB1SA	0.936	0.760	DSPREAD1WU	0.989	0.720
NAIVE	0.021			0.017			0.013	
1998:I - 2001:I								
BIC								
DFT1SA145	0.828	0.634	FB1TC	0.651	0.431	DFT1TC145	0.742	0.400
DFB1SA	0.835	0.640	FT1TC145	0.721	0.477	DFB1TC	0.753	0.406
FT1TC145	0.847	0.649	DFB1TC	0.738	0.488	FT1TC145	0.801	0.431
EuroCOIN	0.857	0.657	OECDcycleEA	0.759	0.502	DEarlyBird	0.814	0.438
DFT1TC145	0.875	0.670	DFT1TC145	0.762	0.504	EarlyBird	0.825	0.444
DIfoR1	0.914	0.700	DIfoR3	0.795	0.526	FB1TC	0.867	0.467
DOECDcycleEA	0.918	0.703	EarlyBird	0.806	0.533	DEuroCOIN	0.870	0.468
PcGets CON								
DFB1TC	0.841	0.644	FB1TC	0.675	0.447	DFT1TC145	0.741	0.399
FB1TC	0.900	0.690	FT1TC145	0.739	0.489	DFB1TC	0.780	0.420
FT1TC145	0.918	0.703	DFB1TC	0.802	0.530	EarlyBird	0.828	0.446
FT1SA145	0.930	0.713	EuroCOIN	0.807	0.534	DEarlyBird	0.837	0.451
DSPREAD1SU	0.934	0.715	OECDcycleEA	0.812	0.538	DEuroCOIN	0.890	0.479
DFT1SA145	0.935	0.716	DFT1TC145	0.818	0.542	DFB1SA	0.893	0.481
DFT1TC145	0.936	0.717	DOECDcycleEA	0.830	0.549	OECDcycleGer	0.898	0.483
NAIVE	0.025			0.018			0.014	
2001:II - 2004:IV								
BIC								
DEU99	0.758	1.114	DDEESI	0.819	1.152	FAZ	0.894	1.531
IfoR3	0.809	1.189	DEAESI	0.823	1.158	DIfoR1	0.972	1.664
DDEESI	0.809	1.190	DEUESI	0.842	1.185	SPREAD2WX	0.978	1.675
DEA99	0.810	1.191	EUESI	0.845	1.189	DEU99	0.980	1.677
IfoR1	0.810	1.192	DIfoR1	0.884	1.244	DSPREAD2WU	0.988	1.691
DEAESI	0.835	1.229	DEU99	0.885	1.245	DSPREAD1WX	0.989	1.693
DEUESI	0.838	1.232	Sword	0.910	1.280	DSPREAD1WU	0.992	1.698
PcGets CON								
IfoR3	0.788	1.158	DEU99	0.785	1.104	DSPREAD1WU	0.981	1.680
FB1SA	0.813	1.195	DEAESI	0.823	1.158	DSPREAD2WU	0.990	1.695
FT1SA145	0.813	1.196	DDEESI	0.831	1.169	DSPREAD1WX	0.995	1.703
DIfoR1	0.855	1.257	DEUESI	0.842	1.185	DSPREAD2WX	0.999	1.711
DEUESI	0.865	1.273	DIfoR1	0.884	1.244	OECDManufConf	1.011	1.731
DEU99	0.869	1.278	DEA99	0.920	1.294	SPREAD2WU	1.020	1.746
ZEW	0.884	1.300	DOECDManufConf	0.927	1.305	SPREAD2WX	1.021	1.748
NAIVE	0.016			0.015			0.013	